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(54) **OPTICAL TRANSMISSION CONNECTING ASSEMBLY**

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G02B 6/42 (2006.01)

(52) **U.S. Cl.**

CPC . ***G02B 6/43*** (2013.01); *G02B 6/428* (2013.01); *G02B 6/4214* (2013.01)

(58) **Field of Classification Search**

CPC G02B 6/43
See application file for complete search history.

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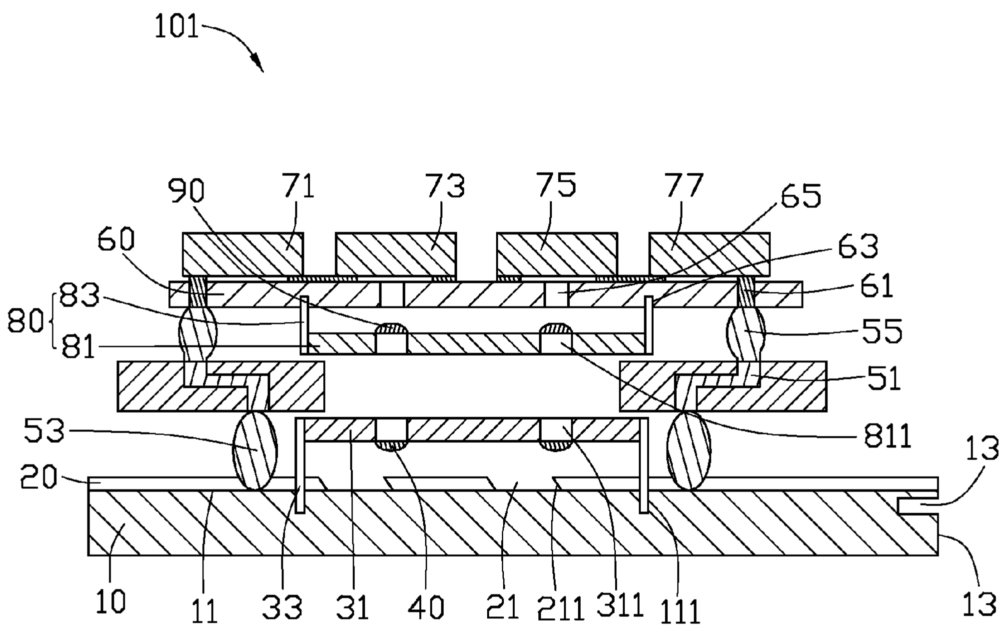
(57) **ABSTRACT**

An optical-electrical conversion module includes a circuit board, a planar optical waveguide formed on the circuit board, two first lenses and two second lenses mounted above the planar optical waveguide, a base plate electrically connected to the circuit board, and an optical signal emitting member and an optical signal receiving member mounted on the base plate. The planar optical waveguide forms two inclined surfaces. The base plate is positioned above the second lenses. Optical signals are reflected by the inclined surface, and are transmitted to the optical signal receiving member. The optical signal receiving member converts the optical signals to electrical signals to transmit to the circuit board. Electrical signals of the circuit board are converted to optical signals via the optical signal emitting member, and then are transmitted to the planar optical waveguide. The present disclosure further provides an optical transmission connecting assembly using the optical-electrical conversion module.

8 Claims, 2 Drawing Sheets



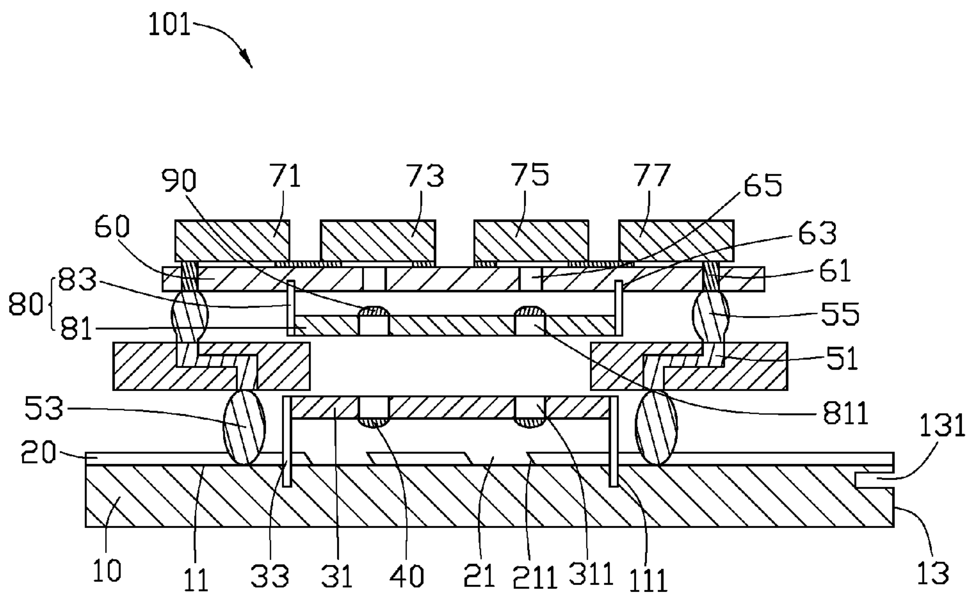

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FIG. 1

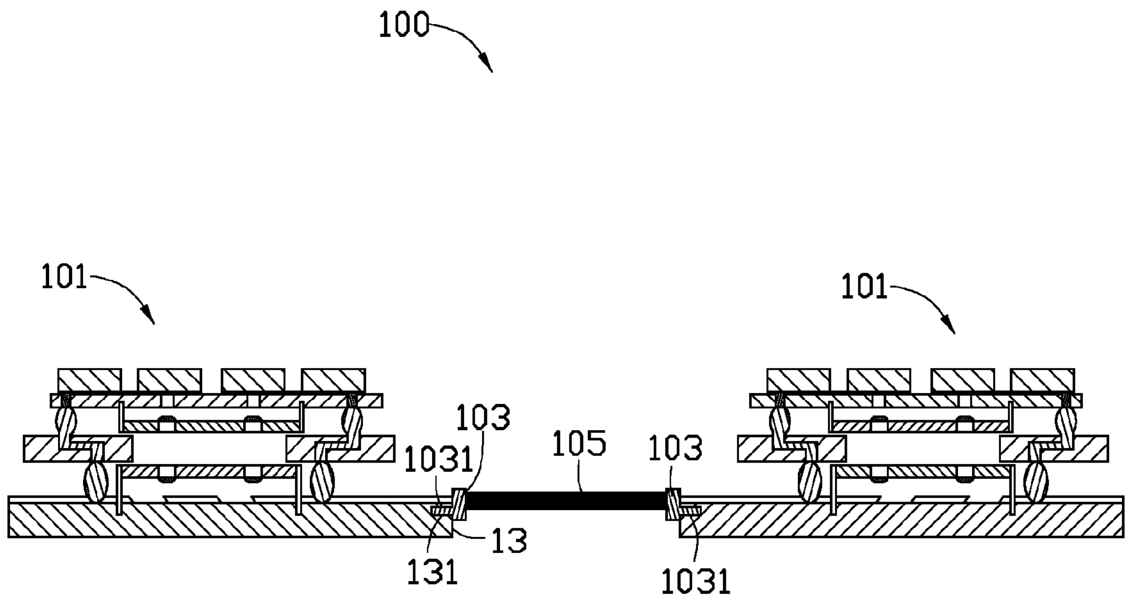

FIG. 2

OPTICAL TRANSMISSION CONNECTING ASSEMBLY

BACKGROUND

1. Technical Field

The present disclosure relates to optical-electrical conversion modules, particularly to an optical-electrical conversion module and an optical transmission connecting assembly using the optical-electrical conversion module.

2. Description of Related Art

Optical communication is popular due to its higher speed and larger capability. An optical-electrical conversion module may include a plurality of optical components (such as an optical signal emitting member or an optical signal receiving member) mounted on a circuit board. When assembling the optical-electrical conversion module, the optical components may be bonded on the circuit board by colloidal silver, and a plastic cover may be mounted on the circuit board by UV glue, for covering the optical components. An optical waveguide is inserted into the cover, for transmitting optical signals. Because the optical components are precisely designed of higher degree of complexity, thus an automatic assembling thereof may be difficult to be realized. Therefore, a manual assembling of the optical-electrical conversion module may be suitable. However, the manual assembling of the optical-electrical conversion module may increase the costs and decrease the assembling efficiency.

Therefore, there is room for improvement in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the present disclosure. Moreover, in the drawings, like reference numerals designate corresponding parts throughout several views.

FIG. **1** is a sectional view of an embodiment of an optical-electrical conversion module.

FIG. **2** is a sectional view of an embodiment of an optical transmission connecting assembly including a pair of the optical-electrical conversion module shown in FIG. **1**.

DETAILED DESCRIPTION

FIGS. **1** and **2** show an embodiment of an optical transmission connecting assembly **100**. The optical transmission connecting assembly **100** includes a pair of optical-electrical conversion modules **101**, a pair of connecting members **103**, and an optical waveguide **105**. The optical waveguide **105** is connecting the pair of optical-electrical conversion modules **101** via the pair of connecting members **103**. See FIG. **1**, one of the optical-electrical conversion modules **101** is reversed **180** degrees relative to the other. The optical-electrical conversion module **101** is configured to convert optical signals to electrical signals or convert electrical signals to optical signals. The optical waveguide **105** is used to transmit optical signals between the pair of optical-electrical conversion modules **101**. In the illustrated embodiment, the optical waveguide **105** is a foldable optical waveguide.

The optical-electrical conversion module **101** includes a circuit board **10**, a planar optical waveguide **20**, a first mounting member **30**, at least two first lenses **40**, at least two soldering plates **50**, a base plate **60**, a first driving member **71**, an optical signal emitting member **73**, an optical signal receiving member **75**, a second driving member **77**, a second mounting member **80**, and at least two second lenses **90**. The planar optical waveguide **20** is formed on the circuit board **10**. The first mounting member **30** is detachably latched with the circuit board **10**, and is located above the planar optical waveguide **20**. The at least two first lenses **40** are mounted on the first mounting member **30**, and are positioned above the planar optical waveguide **20**, for receiving and transmitting optical signals from or to the planar optical waveguide **20**. The two soldering plates **50** are soldered on the circuit board **10** adjacent to two opposite ends of the first mounting member **30** via a plurality of solder balls **53**, and are located above the first mounting member **30**. The soldering plates **50** are electrically connected to the circuit board **10**.

The base plate **60** is mounted on and above the soldering plate **50**. The two opposite ends of the base plate **60** are soldered with the corresponding soldering plate **50**. In the illustrated embodiment, the base plate **60** is soldered on the soldering plate **50** via a plurality of solder balls **55**, and is electrically connected to the soldering plate **50**, to enable the base plate **60** to be electrically connected to the circuit board **10**. The first driving member **71**, the optical signal emitting member **73**, the optical signal receiving member **75**, and the second driving member **77** are mounted on a side of the base plate **60** away from the circuit board **10**, and are electrically connected to the circuit board **10** via the soldering plate **50**. The first driving member **71** controls the optical signal emitting member **73** to convert electrical signals from the circuit board **10** to optical signals. The second driving member **77** controls the optical signal receiving member **75** to convert the optical signals to electrical signals to send to the circuit board **10**.

The second mounting member **80** is detachably latched with a side of the base plate **60** facing the circuit board **10**, and is located above the first mounting member **30**. The at least two second lenses **90** are mounted on the second mounting member **80**, and are positioned at a side of the base plate **60** adjacent to the circuit board **10**. The at least two second lenses **90** are aligned with the optical signal receiving member **75** and the optical signal emitting member **73**. One of the at least two second lens **90** is aligned with the optical signal emitting member **73** and configured for receiving optical signals from the optical signal emitting member **73** and transmitting the optical signals to the corresponding one of the first lenses **40**, and the other one of the at least two second lens **90** is aligned to the optical signal receiving member **75** and configured for receiving optical signals from the corresponding the other one of the first lenses **40** and transmitting the optical signals to the optical signal receiving member **75**. The connecting member **103** detachably latches with the circuit board **10**. An end of the optical waveguide **105** connects with the connecting member **103**, and the optical waveguide **105** couples with the planar optical waveguide **20**.

The circuit board **10** includes a first latching surface **11** towards the first mounting member **30**, and a second latching surface **13** adjacent to the first latching surface **11** and towards the optical waveguide **105**. The first latching surface **11** defines at least one first latching groove **111**, for latching the first mounting member **30**. The second latching surface **13** defines a locking groove **131**, for latching the connecting member **103**. In the illustrated embodiment, the number of the first latching groove **111** is two.

The planar optical waveguide **20** is positioned on the circuit board **10**, and defines two openings **21**. Each opening **21** includes an inclined surface **211** adjacent to the optical waveguide **105**, and an included angle of the inclined surface **211** relative to a bottom surface of the opening **21** is about 45 degrees. In the illustrated embodiment, the planar optical waveguide **20** is coated on the circuit board **10** via a photoresist spin coater. The inclined surface **211** is manufactured by semiconductor lithography processing.

The first mounting member **30** includes a main body **31**, and a pair of first latching portions **33** extending from two ends of the main body **31** towards the circuit board **10**. The main body **31** defines two first through holes **311** above the corresponding inclined surfaces **211**, respectively. The first latching portions **33** are latched on the first latching grooves **111** of the circuit board **11**. In other embodiment, the number of the first latching portion **33** can be one, three or more, and when the number of the latching portion is one, the latching portion may be positioned at a substantially middle portion of the main body **31**.

In the illustrated embodiment, there are two first lenses **40** mounted on corresponding first through holes **311**, and are aligned with the corresponding inclined surface **211** of the planar optical waveguide **20**. In other embodiment, the number of the first lens can be three, four, or more, and the number of the first through holes **311** may be three, four, or more, correspondingly.

The two soldering plates **50** are soldered at opposite ends of the first mounting member **30** via the solder balls **53**, and are parallel to the circuit board **10**. Each soldering plate **50** includes a metallic bonding pad **51** passing through the soldering plate **50**. When the soldering plate **50** is soldered to the circuit board **10**, the solder balls **53** are soldered on the metallic bonding pad **51**, for electrically connecting the soldering plate **50** and the circuit board **10**.

In the illustrated embodiment, the base plate **60** is a silicon plate, and located above the first mounting member **30**. The base plate **60** includes two metallic bonding pads **61** passing through two opposite ends of the base plate **60**. The base plate **60** is soldered to the soldering plate **50** via soldering the solder balls **55** with the metallic bonding pads **51** and the metallic bonding pads **61**, for electrically connecting the base plate **60** with the circuit board **10** via the soldering plate **50**. The base plate **60** defines two second latching grooves **63**, and two second through holes **65** located between the two second latching grooves **63**. The second latching grooves **63** are configured for latching with the second mounting member **80**. The second through holes **65** are aligned with the corresponding inclined surface **211** of the planar optical waveguide **20**. In other embodiments, the base plate **60** may be directly soldered to the circuit board **10**.

The first driving member **71**, the optical signal emitting member **73**, the optical signal receiving member **75**, and the second driving member **77** are mounted on a side of the base plate **60** adjacent to the circuit board **10**, and the optical signal emitting member **73** and the optical signal receiving member **75** are aligned with one corresponding second through hole **65**, respectively. In the illustrated embodiment, the first driving member **71**, the optical signal emitting member **73**, the optical signal receiving member **75**, and the second driving member **77** are mounted on the base plate **60** via flip chip processing and eutectic bonding. The first driving member **71** is electrically connected to the optical signal emitting member **73**, and the second driving member **77** is electrically connected to the optical signal receiving member **75**. An end of the first driving member **71** and an end of second driving member **77** are respectively mounted on one corresponding metallic bonding pad **61**, for electrically connecting with the circuit board **10**. The first driving member **71** controls the optical signal emitting member **73** to receive electrical signals, and convert the electrical signals to optical signals. The second driving member **77** controls the optical signal receiving member **75** to receive optical signals, and convert the optical signals to electrical signals. In other embodiment, the first driving member **71**, the optical signal emitting member **73**, the optical signal receiving member **75**, and the second driving member **77** may be pasted or bonded on the base plate **60** via colloidal silver.

The second mounting member **80** is similar to the first mounting member **30**, and includes a base body **81**, and a pair of second latching portions **83** extending from two ends of the base body **81** towards the base plate **60**. The base body **81** defines two third through holes **811**. The second latching portions **83** are latched in the second latching grooves **63** of the base plate **60**, and the third through holes **811** are aligned with the corresponding second through holes **65** and the corresponding first through holes **311**. In other embodiment, the number of the latching portion **83** may be one, three, four or more. In the illustrated embodiment, there are two second lenses **90** mounted on the third through holes **811**, and coupling with the first lenses **40**. In other embodiments, the number of the second lenses **90** can be three, four, or more, and the number of the third through holes **811** may be three, four, or more, correspondingly.

A positioning portion **1031** protrudes from the connecting member **103**, and is latched in the locking groove **131** of the circuit board **10**. The optical waveguide **105** is connected with the connecting member **103**, and coupled with the planar optical waveguide **20**.

In assembly, the planar optical waveguide **20** is coated on the circuit board **10**. The first latching portions **33** of the first mounting member **30** are latched with the first latching grooves **111** of the circuit board **10**. The first lenses **40** are mounted on the first mounting member **30**, and aligned with the first through holes **311**. The soldering plates **50** are soldered on the circuit board **10** via the solder balls **53**, and is located at two opposite sides of the first mounting member **30**. The first driving member **71**, the optical signal emitting member **73**, the optical signal receiving member **75**, and the second driving member **77** are mounted on the base plate **60** one by one. The second latching portions **83** of the second mounting member **80** are latched with the second latching groove **63** of the base plate **60**. The second lenses **90** are mounted on the second mounting member **80**, and aligned with the first lenses **40**. The base plate **60** is soldered on the soldering plates **50** via the solder balls **55**. The positioning portions **1031** of connecting member **103** is latched with the locking groove **131** of the circuit board **10**. The optical waveguide **105** is inserted into the connecting member **103**, and coupling with the planar optical waveguide **20**.

In use, electrical signals from the circuit board **10** are transmitted to the optical signal emitting member **73** by through the soldering plates **50** and the base plate **60**. The optical signal emitting member **73** converts the electrical signals to optical signals, and the optical signals are transmitted to the inclined surface **211** of the planar optical waveguide **20** via the corresponding second through hole **65**, the corresponding second lens **90**, and the corresponding first lens **40**. The inclined surface **211** then reflects the optical signals to the planar optical waveguide **20**, and the optical signals are transmitted parallel to the circuit board **10**, and then transmitted to the optical waveguide **105**. After the optical signals are transmitted to the planar optical waveguide **20** of the other one of the optical-electrical conversion modules **101** from the optical waveguide **105**, the optical signals are reflected by the inclined surface **211**, and are transmitted to the corresponding first lens **40** along a direction perpendicular to the circuit board **10**. The optical signals are further transmitted to the optical signal receiving member **75** via the corresponding second lens **90** and the corresponding second through hole **65**. The optical signal receiving member **75** receives and converts the optical signals to electrical signals, and the electrical signals are transmitted to the circuit board **10** via the soldering plates **50**. The electrical signals are then transmitted to the optical signal emitting member **73** at the same one of the optical-electrical conversion modules **101** and converted to optical signals, and due to the reversed arrangement of the optical-electrical conversion modules **101**, the optical signals can be finally transmitted to the optical signal receiving member **75** at the other one of the optical-electrical conversion modules **101**, thereby forming working loop between the pair of optical-electrical conversion modules **101**.

In other embodiment, the positioning portions **1031** can be positioned on the optical waveguide **105**, and then the connecting members **103** can be omitted. In other words, the optical waveguide **105** may be directly mounted on the circuit board **10**. The second mounting member **80** may be latched on the circuit board **10**. The first mounting member **30** and the second mounting member **80** can be replaced by other structures, while ensuring that the first lenses **40** and the second lenses **90** are located between the circuit board **10** and the base plate **60**. The optical signal receiving member **75** and the optical signal emitting member **73** may be mounted on a side of the base plate **60** adjacent to the circuit board **10**.

It is believed that the present embodiments and their advantages will be understood from the foregoing description, and it will be apparent that various changes may be made thereto without departing from the spirit and scope of the embodiments or sacrificing all of its material advantages.

What is claimed is:

1. An optical transmission connecting assembly, comprising:

a pair of optical-electrical conversion modules with one of the optical-electrical conversion modules being reversed 180 degrees relative to other one of the optical-electrical conversion modules, each optical-electrical conversion module comprising:

a circuit board;

a planar optical waveguide formed on the circuit board, and defining at least two inclined surfaces, for reflecting optical signals;

a base plate electrically connected to the circuit board;

a first mounting member detachably latched with the circuit board, and located between the circuit board and the base plate;

at least two first lenses mounted on the first mounting member, and aligned with the at least two inclined surfaces;

a second mounting member detachably latched with the circuit board, and located between the first mounting member and the base plate;

at least two second lenses mounted on the second mounting member, and positioned between the at least two first lenses and the base plate, each of the at least two second lenses aligned with one corresponding inclined surface and one corresponding first lens;

an optical signal emitting member mounted on the base plate, and aligned with one corresponding second lens, for converting electrical signals to optical signals; and

an optical signal receiving member mounted on the base plate, and aligned with another one corresponding second lens, for converting optical signals to electrical signals; and

an optical waveguide connecting the pair of optical-electrical conversion modules, and coupling with the planar optical waveguides of the pair of optical-electrical conversion modules,

wherein the optical waveguide transmits optical signals to a corresponding one of the at least two inclined surfaces of the corresponding planar optical waveguide, and the corresponding one of the at least two inclined surfaces reflects the optical signals to a corresponding one of the at least two first lenses, the optical signals are further transmitted to the corresponding optical signal receiving member via the corresponding one of the at least two first lenses and the corresponding one of the at least two second lenses, the corresponding optical signal receiving member converts the optical signals to electrical signals to the corresponding circuit board, the corresponding optical signal emitting member converts the electrical signals to optical signals, and the optical signals are transmitted to the corresponding other one of the at least two inclined surfaces via the corresponding other one of the at least two second lenses and the corresponding other one of the at least two first lenses, and then are reflected by the corresponding other one of the at least two inclined surfaces to the planar optical waveguide for transmitting optical signals parallel to the circuit board and return to the optical waveguide, a surface of the circuit board adjacent to the first mounting member defines at least one first latching groove, the first mounting member comprises a main body and at least one first latching portion extending from the main body to the circuit board, and the at least one first latching portion latches in the at least one first latching groove.

2. The optical transmission connecting assembly of claim **1**, wherein the optical transmission connecting assembly further comprises a pair of connecting member, a side of the circuit board adjacent to the optical waveguide defines a locking groove, each connecting member comprises a positioning portion, the positioning portion of each connecting member is latched with the locking groove of one corresponding optical-electrical conversion module, two opposite ends of the optical waveguide are respectively connected to the connecting members.

3. The optical transmission connecting assembly of claim **1**, wherein the optical-electrical conversion module further comprises two soldering plates, each soldering plate comprises a metallic bonding pad, the base plate comprises two metallic bonding pads at two opposite ends thereof, the metallic bonding pad of each soldering plate is soldered to one corresponding metallic bonding pad of the base plate via a plurality of solder balls, and the metallic bonding pads of the soldering plates are soldered to the circuit board.

4. The optical transmission connecting assembly of claim **3**, wherein the optical-electrical conversion module further comprises a first driving member and a second driving member mounted on the base plate, the first driving member is electrically connected to the optical signal emitting member, and controlling the optical signal emitting member to convert electrical signals to optical signals, the second driving member is electrically connected to the optical signal receiving member, and controlling the optical signal receiving member to convert the optical signals to electrical signals.

5. The optical transmission connecting assembly of claim **1**, wherein the main body of the first mounting member defines at least two first through holes, the at least two first lenses are mounted on the at least two first through holes.

6. The optical transmission connecting assembly of claim **5**, wherein a surface of the base plate adjacent to the circuit board defines at least one second latching groove, the second mounting member comprises a base body and at least one second latching portion extending from the base body toward the base plate, the at least one second latching portion latches in the at least one second latching groove.

7. The optical transmission connecting assembly of claim **1**, wherein the base plate defines at least two second through holes aligned with the corresponding optical signal emitting member and the corresponding optical signal receiving member, respectively.

8. The optical transmission connecting assembly of claim **6**, wherein the second mounting member defines at least two third through holes, the at least two second lenses are mounted in the at least two third through holes.

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